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Published in:
Giesserei

Publication date:
2016

Document Version
Publisher's PDF, also known as Version of record

Spot feeding spheroidal graphite iron with exothermic and insulating ram-up sleeves in vertically parted moulds

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January 2016

Improvement of feeder technologies for energy savings in cast iron foundries is not only the title of the project behind this dissertation, it is a good idea that can improve casting yield and reduce production cost, and in turn strengthening the foundries competitive advantage. The approach to solving feeding problems today is for a large part based on methodologies and know-how developed more than 50 years ago. This dissertation addresses the state-of-the-art as it is used presently in the foundries, reviewing the fundamentals of spot feeding cast iron.

The findings presented in this dissertation is based on large-scale quantitative experiments with duplicates for statistical representation. The focus, as stated by the dissertation title, has been: "Spot feeding spheroidal graphite iron with exothermic and insulating ram-up sleeves in vertically parted moulds".

The application of spot feeders (ram-up sleeves) is investigated, showing that this new feeding approach can be used successfully to feed secluded sections in ductile cast iron (EN-GJS-500-7). The feeder efficiency is tested using a high silicon (Si) ductile iron (EN-GJS-450-10). The limits for the examined feeder configurations are documented, showing that the exothermic feeder combinations managed the task successfully, while the insulating feeder combinations were insufficient.

It is shown that the exothermic feeders do not influence the casting microstructure via comparing the microstructure of several colour etches samples from the castings (**Figure 1**), as well as the exothermic and insulating feeders.

The thermal deformation related to the feeder combinations are investigated, and it is found that the thermal gradients created by the feeders could be signified by the deformation of the plane reverse side of the casting. The eutectoid phase transformation is found to be the governing factor. The main difference between the two alloys is that the pearlitic-ferritic EN-GJS-500-7 have twice as long a transformation interval as the fully ferritic EN-GJS-450-10. Knowledge of the deformation magnitude and variance can be used to reduce the machining allowance, subsequently reducing the melt cost and machining wear.

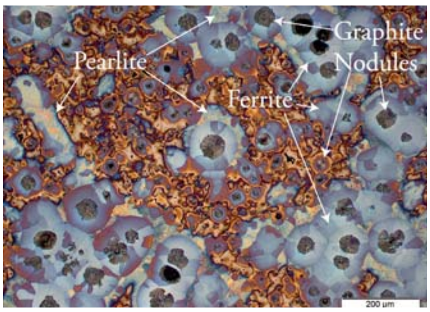

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Figure 1: Colour etched sample from the casting.

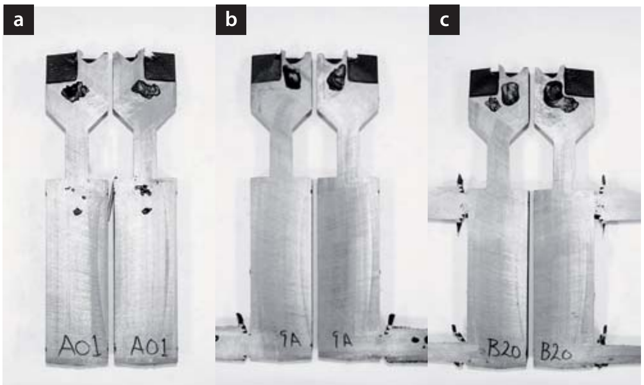

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Figure 2: The examined three different modulus castings.

A series of different spot feeders with insulating or exothermic sleeves materials are investigated for three different modulus castings; 8 mm, 12 mm, and 15 mm (**Figure 2**). It is proved that the required feeder modulus do not scale linearly with the casting modulus. Additionally it is shown that horizontal spot feeder can feed against gravity by optimising the interplay of forces created by the solidifying casting and the feeder itself.

The investigation of the modulus relationship between the casting and the feeder leads to the formulation of a set of driving forces for feeding, accompanied by the pressure loss caused by the solidifying casting and the timing demanded by the feeding requirement. It is shown that the interplay of internal forces can drive a complete feeding process, but also that the frame of optimal function can be very narrow.

Numerical simulation of casting processes and the prediction of porosities are addressed and it is found that some castings and alloys can be reliably simulated with respect to porosities. However, it is also found that for high Si alloy EN-GJS-500-14 the simulation setup cannot provide prediction that correspond to the porosities found in the porosity analysis.

Finally, it is shown how multiple feeders can influence each other's performance even across solidified sections, and that two individual feeders that can retain a liquid connection are able to change the thermal gradients of the casting and the directions of solidification.

The dissertation provides a new approach to feeding secluded sections, a new characterisation of the underlying feeding forces, and new knowledge about the thermal deformation effects caused and controlled by feeding.

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